International Journal of Civil Engineering (IJCE)
ISSN 2278-9987
Vol. 2, Issue 4, Sep 2013, 67-74

International Academy of Science, Engineering and Technology
Connecting Researchers; Nurturing Innovations

OPPORTUNITIES AND LIMITATIONS IN PRACTICING RAINWATER HARVESTING SYSTEMS IN BANGLADESH

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ABSTRACT

The development of a society is significantly dependent on the availability of healthy water. But presently like all the other parts of the world, Bangladesh is facing increasing scarcity of water resources. At this situation, sustainable management of fresh water can be ensured by utilization of alternative water sources. As Bangladesh is privileged by huge quantity of rainwater annually all through the country, rainwater harvesting can be the most potential alternative water supply option for Bangladesh. This paper investigates different local and traditional rainwater harvesting systems practiced in most of the coastal areas of Bangladesh and modern rainwater harvesting systems practiced in urban areas specially in Dhaka city. In spite of being very potential alternative water source, these systems are associated with some limitations. The limitations of both the rural and urban rainwater harvesting systems have been reviewed in this paper through the investigation on the existing systems. To execute these systems more adequately and sustainably some recommendations have been also made as future steps.

KEYWORDS: Suitability of Grey Water Recycling, Limitations**,** Rainwater, Harvesting, Systems

INTRODUCTION

The environment, economic growth and development of Bangladesh are highly influenced by availability and quality of water. Bangladesh largely depends on its rivers for maintaining proper water cycle as it contains one of the largest delta of the world (Mbugua & Snijders 2012). But man-made changes, industrial pollution and neighboring activities upstream have caused exploitation of river water system. As a result the overall natural water flow has deteriorated in an alarming extent. Moreover, Arsenic contamination, salinity intrusion and riverbed siltation are causing water crisis in rural and coastal areas of Bangladesh. On the other hand, groundwater depletion, water pollution and wetland degradation are causing serious pressure on water supply system in urban areas. In future this water crisis will be more intensified and consequently new strategies for water development and management are needed to face national, regional and local water scarcities (Alam & Rahman 2010; Rosegrant 1997). Under these circumstances implementation of alternative water sources is a prime requirement for both the urban and rural areas of Bangladesh to face future challenges.

As Bangladesh is privileged by huge quantity of rainwater almost throughout the country, among all alternative water sources rainwater harvesting can be the most potential one for Bangladesh. Rainwater harvesting is a simple and low-cost technique that can utilize these rainwater as a resource to solve water crisis. Moreover this process needs minimum specific expertise or knowledge and adaptable to a wide variety of conditions (Worm & Hattum 2006). Furthermore rain water harvesting system can be considered as a probable solution for Bangladesh as it is free from arsenic contamination, salinity and other harmful infectious organisms and pathogens (Rana 2006). This technique is also feasible than the other alternative sources as the treatment and distribution cost is less (Haq (n.d)).

This paper has investigated the scopes and feasibility of rainwater harvesting in Bangladesh. A review has been done on existing rainwater harvesting system practicing in rural and urban areas of Bangladesh along with their strength and limitations. The problems which have been associated with these harvesting systems have been analyzed to suggest some recommendations to improve the system in context of Bangladesh.

NECESSITY OF ALTERNATIVE WATER SUPPLY OPTION

Sustainable development and human and ecosystem health is on threat because of continuous depletion and pollution of freshwater (Furumai 2008). The proper balance between water demand and supply has become a delicate matter in modern days because of water stress. Consequently it has become a key concern to create a proper balance between water demand and supply with respect to the social, economic and environmental overheads (Fattahi & Fayyaz 2009). This balance can be achieved by implementing alternative water sources. Proper execution of alternative water sources can reduce pressure on traditional sources. Rainwater harvesting, storm water harvesting are the alternative water supply options for reusing water and wastewater like black water, grey water recycling are the options for recycling for water management (Ahmed & Arora 2012).Among these options rainwater harvesting offers an ideal solution in areas where there is sufficient rain but inadequate ground water supply and surface water resources are either lacking or are insufficient (Haque 2011).

Bangladesh is also in need of simple, affordable, technically feasible and socially acceptable alternative water supply options (Worm & Hattum 2006). Provision of alternative safe water options to the arsenic and salinity affected communities is the topmost priorities in order to alleviate these problems in Bangladesh (Jakariya. 2000). Because at present arsenic-contaminated water directly affects the health of about 35 million people in rural areas of Bangladesh and 86 upazillas covering the coastal belt of Bangladesh are severely affected by salinity (Alam & Rahman 2010; Haq (n.d)). Moreover rapid population growth and unplanned infrastructural development have caused groundwater depletion, reduction of natural groundwater recharge and deterioration of water quality in urban areas of Bangladesh. This enormous pressure on urban water supply can also be resolved by execution of alternative water sources.

SCOPES OF RAINWATER HARVESTING IN BANGLADESH

Availability of rainwater in Bangladesh is quite sufficient even if the rainfall distribution is not consistent all over the country. The average annual rainfall varies from 2200 mm to 2800 mm, considerable portion of which occurs between May and October. Comparatively higher rainfall occurs in the eastern part of the country and lower in the western part of Bangladesh (Haq (n.d)). This amount makes rain water harvesting an obvious solution for the arsenic contamination whereas 50% area of the country is suffering from arsenic contamination making it a nationwide problem.

Scope of rainwater harvesting in a particular area depends on the availability of sites, climatic conditions (specially rainfall) and catchment characteristics. Reliable rainfall data of a certain period in a given catchment is required to design the potential rainwater supply of that catchment. The pattern and frequency of rainy days are also important factor for designing rainwater harvesting. The fewer the annual rainy days or longer the dry period, the more need of rainwater collection in a region.

The eastern part of the coastal area and hilly area of Bangladesh both have serious water source problem but both lie in high rainfall areas. Hilly areas are located along the northeast, east and southeast borders of the country, which include the hills of Mymensingh, Sylhet and Chittagong Hill Tracts (CHT) (Kabir & Faisal (n.d)).Proper harvesting system can utilize the rainfall properly and can be used for both storage and groundwater recharge. People of hilly areas like

Kaptai, Bandarban and Hilltract areas harvest rainwater locally to use the collected water for household use as well as for irrigation and navigation purposes. Some non- governmental organizations have already taken some plans to popularize rainwater harvesting for urban and rural water management (Haq (n.d)). It has been estimated that if about 60% of the rainfall collected from existing rooftops of Dhaka city can be harvested, it could contribute about 200 MLD water available for the total water supply of the city. Around 15% of the total water demand of Dhaka city can be reduced by using rainwater harvesting methods (Jahan & Haider 2012).

EXISTING HARVESTING SYSTEMS

Rural Practices

Small scale rainwater harvesting is performed more or less in all parts of Bangladesh. Large-scale storages are found mostly in the northeastern districts of Mymensingh and Sylhet. Most of the traditional rainwater harvesting systems is practiced in coastal areas of Bangladesh. About 52 indigenous harvesting methods have been practiced by the tribal people because of the lacking of adequate water supply facilities on those areas. The poor economic conditions of these people have restricted them to practice these methods as small scale, area specific, labor intensive and paced with slow rural life. Table 1 is showing some local harvesting systems and their using purposes.

Table 1: Local Harvesting Systems

Local Harvesting System	Purposes of Using
Jhurjhuri, Phour, Thagalok-Kum, Earthen Motka	Household purpose
Cross dam, Retention ponds	Irrigation purpose
Godha ,Thelyathok	Multipurpose (Household, irrigation, navigation)

Jhurjhuri, Phour, Thagalok-Kum are generally used as reservoir to store the water and then collecting them for drinking purpose and other household uses. Jhurjhuri is well dug in a sedimentary rock formation into which water collects through seepage. Because of the natural filtration through soil formations, water stored in a Jhurijhuri is quite clear. Phour is one kind of local water pond which is generally constructed to serve a small community for their common household demands. These ponds have a typical size of about 7-8 m^2(Kabir & Faisal (n.d)). Thagalok-Kum water harvesting system is constructed by using split bamboo (Thagalok) and earthen pitcher (Kum). Water that contributed in the stream by seepage from adjacent hills is obtained with the help of a split bamboo placed at the end of the stream. This water is then directed to an earthern pitcher (Figure 1). This system is designed to provide cool drinking water to a small community people (Kabir & Faisal (n.d)).

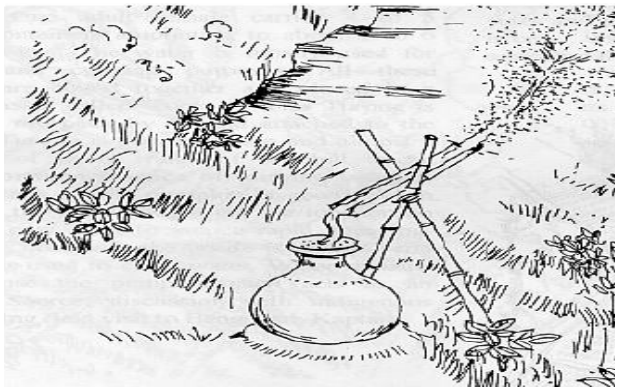

Figure 1: Thagalok-Kum (Bose et al. 1998)

Cross dams generally use for irrigation purposes like natural vegetation, fish culture and rising ducklings. These dams are constructed across perennial creeks between two hills. Godha and Thelyathok are also a kind of cross dam which are developed across small hill creek to use water in arid season. Godha helps in transporting bamboo harvested in

upstream areas. Stored water of Godha is also used for irrigation and household purposes. Bamboo and wooden pegs are used to support the earthen body of Godha and Thelyathok. The only difference between Godha and Thelyathok is that a diversion drain beside the dam is used in the later one to release excess runoff(Kabir & Faisal (n.d)).

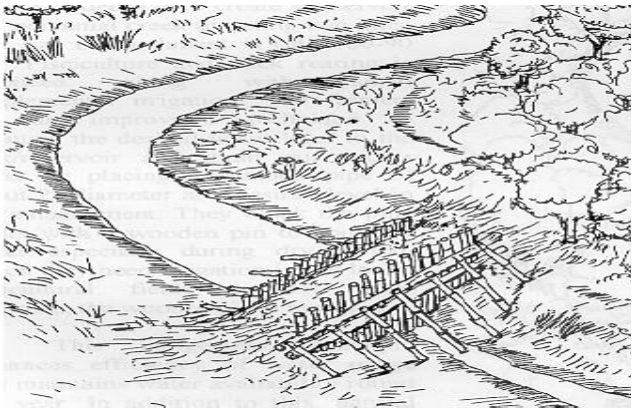

Figure 2: Godha (Bose et al. 1998)

Examples of using small scale rainwater harvesting system have also been observed in Khulna district. In three villages (Shanta, Kumkhali and Uttar Fakirabad) of Garuikhali Union at Paikgacha Thana under Khulna district, almost all the families are involved in rainwater collection for consumption. In this area most of the people depends on rain water and pond water for drinking purpose due to severe salinity problem. The process used by these villages is shown in Figure 3 (Rana 2006). Most of the people in this area use earthen motka as storage tank whereas very few people use pacca tank. Cloth, straw/Golpata roof and polythene are used as catchment material over storage tank. Usually bamboo and rope are used for guttering between storage tank and catchment. Only few families use PVC pipe for guttering. No modern practice of using flush device to remove first flush of rainwater is available in these villages (Rana 2006).

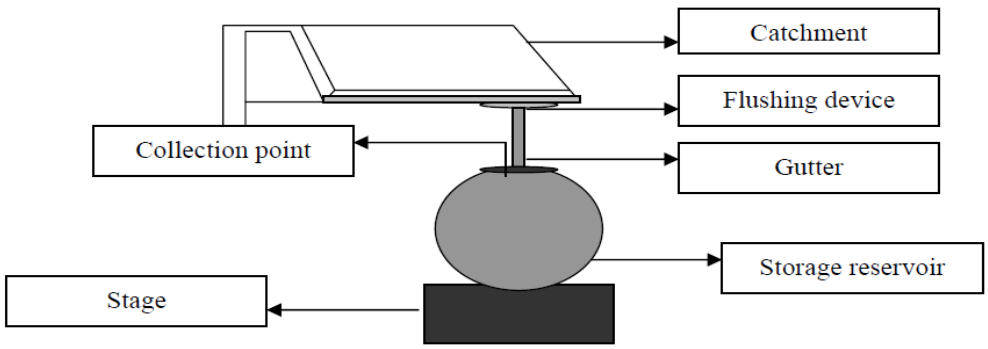

Figure 3: Earthen Motka

Underground rainwater harvesting system is also used in some rural areas. The most popular underground rainwater harvesting system is tube well water system. Under the tube well water system different technology is used which is integrated with underground rain water tank. They are mainly used for the supply of drinking water as well as other domestic purpose (Haque 2011).

Urban Practices

Increasing rate of transferred people from rural to urban areas and unplanned infrastructural system set the balance of water supply and demand on risk. This increasing population is putting extra load on underground aquifers that has reduced the piezometric level of Dhaka city by around 20 meter in the last decade. Several organizations are working currently to employ the rainwater harvesting system in different locations of Dhaka city to decrease the pressure on Dhaka Water Supply & Sewerage Authority (DWASA). Water Aid, one of the renowned organizations of Bangladesh has been

working for a long time placing rainwater harvesting as their priority agenda. They have constructed few Rain Water Harvesting Systems (RWHS) with support from different NGOs-PSTC and VERC to find out the knowledge gaps and opportunities in context of urban areas. These plants are in fact constructed to investigate the scopes of rainwater harvesting in urban areas of Bangladesh. These demo plants have been constructed at two educational institutions Bangladesh University of Engineering & Technology (BUET) & Independent University of Bangladesh (IUB), one government organization Public Works Department (PWD) and in the office premises of an NGO–Village Education Resource Centre (VERC).

One portion of the collected water of the rainwater harvesting system (RWHS) installed in BUET is used for toilet flushing and another portion is diverted for groundwater recharging system. This RWHS is installed for reducing the water logging problem for the period of monsoon. The rooftop of the cafeteria and auditorium has been used as the catchment of the system (WaterAid 2011a). Two recharge wells have been constructed, one having a height of 50ft and another one having 60ft. Beforing entering into the recharge wells rainwater is passed through the filtration chamber. Monitoring wells have constructed later to measure the quantity of recharge and storage. About 1.43 million litre per year rainwater could be harvested by using this RWHS (WaterAid 2011a).

Catchment **Plumbing**

Rainwater Connection for Toilet **Flushing Recharge Well**

Figure 4: Rainwater Harvesting System of BUET

The RWHS installed at the academic and gymnasium building of IUB is also designed for using rainwater in different purposes except drinking. This RWHS also has both storage facility and recharging system. The stored water is used for toilet flushing of the toilets of academic building as well as in the basement of the building. Another RWHS system is used for recharging purpose (WaterAid 2011b). This plant is also a good resource of research and investigation for the students. Two monitoring wells had been constructed to measure the quantity of recharge and storage. When this system were installed it had been estimated that a cost of about BDT 34,000 would be saved per annum including DWASA bill and cost of electricity required to extract water (WaterAid 2011b).

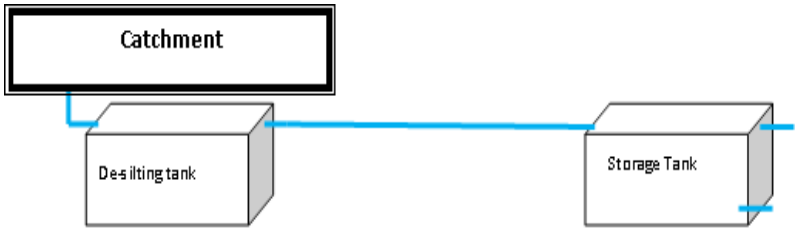

Figure 5(a): Rainwater Harvesting System of IUB (Storage System) (WaterAid 2011b)

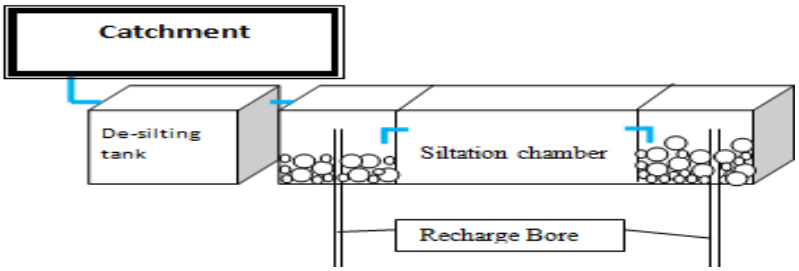

Figure 5(b): Rainwater Harvesting System of IUB (Recharge System) (WaterAid 2011b)

Previously in VERC, groundwater had been used as main water supply source. Because of the continuous depletion of the groundwater the organization was looking for a sustainable option as water source in dry season. The RWHS was installed in head office premises for supplying water to training centre and head office and to mitigate the problem regarding water availability (WaterAid 2011c). In this system both storage tank and recharge well are installed together and parallel to each other. The RWHS system installed at head office premises of PWD is also using collected rainwater for toilet flushing. About 0.6 million litres of rainwater per year could be harvested by using a portion of rooftop of the main building.

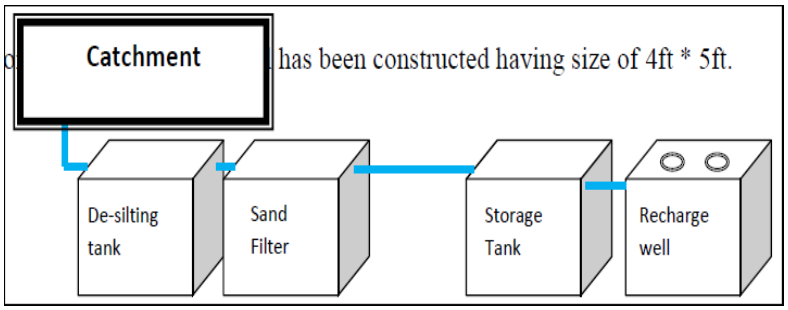

Figure 6 : Rainwater Harvesting System of VERC (WaterAid 2011c)

Figure 7: Recharge Well of RWHS (VERC)

PROBLEMS ASSOCIATED WITH THE EXISTING SYSTEMS

All the existing methods practiced in both rural and urban areas have some merits as well as some limitations. Traditional RWHS is developed in particular socio cultural and physical setting to serve specific needs of rural or tribal people. These systems are cost effective and simple and can be used in multiple purposes without any permanent structure

and with proper community participation. But as these systems are constructed in small scale, they could be helpful only for small communities. Specially in the tribal areas, water demand cannot be met only with small scale harvesting system as population is transferring often from the other part of the country. These traditional systems are also losing their importance as these are location specific. For instance, Thagalok Kum can be used with small creek. But this type of creek is not available in flat areas. So the system is only functional in hilly areas. Most of the indigenous methods are not properly maintained because of the lack of public awareness as most of the tribal people are not enough knowledgeable. They lose most of their valuable time of the day in monitoring or working with the labor intensive methods. Most of these systems have lost their reliability compared to the modern alternative options.

One of the biggest challenges of implementing any alternative water supply option in urban areas is incorporating the new system with the existing water supply system. If the RWHS is not integrated properly with the existing water supply system, both systems will be hampered. Rainwater contains most of the gases in dissolved form in proportion to their abundance in the atmosphere of that particular area. Rainwater also contains sediments, dust, aerosols, particulates, and anthropogenic gases that result from industrial discharge, biomass and fossil fuel burning. So, proper flirtation system is necessary to ensure quality water. All the demo plants of Dhaka city that have been discussed in the previous paragraph are mainly using rainwater for toilet flushing or very general purpose. High quality of water has not been ensured with these plants as suitable filtration system is absent in most of them. Catchment maintenance is also necessary in the RWHS of urban areas as the catchment size is quite large compared to the rural areas. The catchments of the demo plants have been using for many other purposes, for this reason awareness about the catchment clean-up is needed to be built up among the local people.

Rainwater harvesting system is site specific and depends on local rainfall hence it is difficult to give a generalized idea and make it successful for both urban and rural areas. Moreover sometimes incorrect prediction of rainfall can make the system unusable.

RECOMMENDATIONS

Some awareness building programs are needed to be conducted to make the rural indigenous people proficient in using rainwater harvesting systems appropriately. Local harvesting systems are easy to implement but not always sustainable and their effectiveness are largely dependent on the local condition. So, proper investigation should be done before selecting and implementing a system for a particular area to make it sustainable. On the other hand, most of the rainwater harvesting systems of Dhaka city discussed before is experimental approaches taken by Wateraid. So, before using them in large scale, some alterations and modifications are required to be supplemented with these systems. Moreover proper maintenance has to be ensured for appropriate execution of rainwater harvesting systems. Water quality should be tested frequently to observe the suitability of the systems. Catchments of the system should be properly maintained, filtration systems should be constructed according to the water using purpose, and plumbing should be adequate and regularly checked. Incorporating both rural and urban systems can be more environmental friendly and sustainable.

CONCLUSIONS

Among all the alternatives rainwater harvesting is an environmentally sound, reliable and feasible option for Bangladesh. It is a suitable system for both the urban and rural areas of the country to reduce pressure on traditional sources. But most of the rainwater harvesting systems developed in rural or tribal areas of Bangladesh is location specific. Moreover rural people are not enough knowledgeable to monitor these systems effectively. On the other hand

incorporating the new rainwater harvesting system with the existing water supply system is a great challenge for urban areas. The existing rainwater harvesting systems cannot still provide high quality of water due to the absence of proper filtration system. However, effective utilization of rainwater harvesting system in Bangladesh requires appropriate training on implementation and monitoring as well as improvisation of the systems.

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